TRANSPORTATION RESEARCH BOARD
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IDEA *Innovations Deserving Exploratory Analysis Project*

TRANSIT COOPERATIVE RESEARCH PROGRAM

INTERNET INFORMATION SHARING FOR TRANSIT MAINTENANCE

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Report of Investigation

IDEA PROJECT FINAL REPORT

Contract Transit-15

IDEA Program
Transportation Research Board
National Research Council

July 1997

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INNOVATIONS DESERVING EXPLORATORY ANALYSIS (IDEA) PROGRAMS MANAGED BY THE TRANSPORTATION RESEARCH BOARD (TRB)

This Transit-IDEA investigation by Victor Kiernan of Kiernan Transit Associates was completed as part of the Transit Cooperative Highway Research Program (TCRP). The Transit-IDEA program is one of the three IDEA programs managed by the Transportation Research Board (TRB) to foster innovations in highway and intermodal surface transportation systems. The other two IDEA program areas are NCHRP-IDEA, which focuses on products and results for transit practice, in support of the National Cooperative Highway Research Program (NCHRP), and ITS-IDEA, which focuses on products and results for the development and deployment of intelligent transportation systems (ITS), in support of the U.S. Department of Transportation's national ITS program plan. The three IDEA program areas are integrated to achieve the development and testing of nontraditional and innovative concepts, methods, and technologies, including conversion technologies from the defense, aerospace, computer, and communication sectors that are new to highway, transit, intelligent, and intermodal surface transportation systems.

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EXECUTIVE SUMMARY

IDEA PRODUCT

A system architecture to share maintenance information between transit properties through use of the Internet and World Wide Web (WWW) was designed and trial tested, and guidelines were developed for adoption of basic and enhanced systems by transit maintenance facilities. The system design allows for retrieval of information from relational databases on parts held by transit rapid transit agencies for sale, exchange, or sharing with other properties. An Internet website was designed with the capability of querying a prototype database of bus bearings parts commonly used by major transit agencies in the San Francisco Bay Area.

The website also provided access to Internet resources relevant to transit maintenance functions and demonstrated the ability to send electronic mail (e-mail) and to submit text comments using an easy-to-use graphic user interface. Low-cost, standalone Internet connection hardware with pre-configured and installed software which require little systems administration was provided to participating maintenance managers. The technical feasibility of developing a nationwide parts exchange system has been demonstrated.

Creation of an Internet-based transit maintenance communications system requires several steps: Developing upper-level policy and management support; providing training, information, and hardware and software connectivity to participating facilities; laying a groundwork by implementing Internet-compatible computer communications and document preparation protocols and integrating these functions with existing transit agency MIS systems and structures; setting up Internet and internal Intranet host sites and systems; developing agency policies and standards on the use of the Internet for maintenance information sharing and exchange, including electronic commerce; promoting Internet usage to gain the benefits of economy of scale and scope; and supporting and encouraging maintenance, purchasing, and overall managers in applying the new technology.

CONCEPT AND INNOVATION

By using the Internet, local and wide-area computer networks, and other digital communication systems using Internet-compliant protocols, transit properties could achieve cost savings in retrieval and dissemination of up-to-date management and operational information on contracts, safety issues, toxic substance handling, environmental regulation and protection, staff training, maintenance procedures, parts and system specifications, parts pricing and availability, joint parts or equipment purchasing, a greatly expanded spare parts base, and improvements in other areas related to maintenance.

Different transit agencies maintain spare parts inventories, but there is no system for exchanging information and parts with other transit agencies. As vendors provide product and pricing information and on-line parts and equipment purchasing, those agencies that are able to take advantage of these offerings will be able to achieve labor and cost-savings by eliminating overhead associated with procurement through intermediary distributors and retailers. We demonstrated that connection to the Internet can be made easy and cost-effective, and we believe that our project has introduced some participating agency managers to the potential benefits of using the Internet.

IDEA PROJECT INVESTIGATION AND PROGRESS

After an initial survey of Bay Area agencies (Stage 1), the study developed an Internet website called Transpo.NET (http://www.transpo.net) as a central information source focused on the sale or exchange of parts among agencies to test the design of a simple system. Participating agencies were offered standalone Internet terminals (WebTV set-top boxes and pre-configured Internet access and functional software) that were independent of existing agency computer systems (Stage 2) to demonstrate the feasibility of connecting transit agency maintenance offices. This model was tested and demonstrated to maintenance managers, and their comments and suggestions were obtained (Stage 3).

Since this pilot project did not have direct access to installed agency computer systems and parts databases, we decided to test the concept by placing our Internet connection hardware physically close to existing agency computer terminals so that the operator could easily access both. We provided those managers who were willing to participate in testing the system with dedicated Internet computers with installed software and Internet access accounts. Using the WebTV network as an Internet Service Provider, the agencies are able both to access the WWW for information and to use electronic mail to communicate with each other.

We developed a database of bus bearings parts common to local transit agencies along with associated stock part numbers used by major Bay Area agencies and their suppliers. We developed a Parts Exchange Bearings Reference Table that cross-references each bearing by all of its part numbers, and posted a table based on these data on our website.

PLANS FOR FUTURE IMPLEMENTATION

The research results from our pilot project suggest that implementation of Internet-based information sharing among agencies requires a two-pronged approach: regional, local, and individual agency policy direction from above to provide the organizational incentive to devote attention and resources to developing more efficient use of available technology, and leadership in implementation by a handful of progressive agencies to demonstrate the feasibility and practical means of using the Internet while creating competitive pressures on other agencies by serving as examples in cost savings and improved efficiency.

CONCLUSIONS

Public transportation is not a local industry; it is nationwide and ready for a model demonstrating the cost-saving, increased safety, and increased efficiency that global communication can promote.

The challenge lies in getting individual agencies, currently burdened by limitations in staffing and expertise, and solely accountable to local government entities and constituencies, to gear-up to embrace new ways of communicating and doing business. The use of the Internet offers long-term benefits to transit agencies, but agencies need to perceive an immediate positive impact on reducing operating budgets. Moreover, there are few incentives for individual procurement or maintenance professionals to divert scarce time and resources to develop the necessary familiarity with the recent and rapid development in Internet technology and commerce.

Many state and local officials and transit maintenance managers and personnel have been very positive about the concept, but they are uncertain about how it will be accomplished. It is better if the agencies help direct and shape the course of their Internet usage now. If the private sector alone dictates the terms by which transit agencies use the Internet, current inefficient and wasteful practices will be repeated using the new technology. Transit maintenance managers could immediately benefit from sharing information about part and system specifications, contract terms and conditions, planned purchasing, safety and maintenance procedures and manuals, and other operational issues and concerns.

Joint research and interagency cooperation would allow for development of a standardized system that could be implemented by a given agency with minimal risk or disruption. Just as the Internet developed from joining local networks together, transit agencies must prepare to employ the technology of the Internet and Intranet to meet their immediate local needs and expand their reach and capabilities beyond their local areas by developing and supporting joint endeavors in information sharing and exchange.

INTERNET INFORMATION SHARING FOR TRANSIT MAINTENANCE: A PILOT STUDY

IDEA PRODUCT

A system architecture to share maintenance information between transit properties through use of the Internet and World Wide Web (WWW) was designed and trial tested, and guidelines were developed for adoption of basic and enhanced systems by transit maintenance facilities.

The system design allows for retrieval of information from relational databases on parts held by transit rapid transit agencies for sale, exchange, or sharing with other properties. An Internet website was designed with the capability of querying a prototype database of bus bearings parts commonly used by major transit agencies in the San Francisco Bay Area. A demonstration table, showing stock numbers for bus bearings parts used by manufacturers and transit agencies, was posted on the Internet and made accessible to registered users through a simple password authentication program.

The website also provided access to Internet resources relevant to transit maintenance functions and demonstrated the ability to send electronic mail (e-mail) and to submit text comments using an easy-to-use graphic user interface. Low-cost, standalone Internet connection hardware with pre-configured and installed software which require little systems administration was provided to participating maintenance managers.

The technical feasibility of developing a nationwide parts exchange system has been demonstrated. Transit Properties could rely upon existing computer resources from within their organizations or purchase inexpensive desktop personal computers or the new "thin client" network computers to access the Internet to exchange maintenance information, including parts availability and pricing.

Connections to the Internet could be through an agency's existing network behind appropriate "firewall" security or through an "air-gap" standalone system, not connected to any agency systems. A third-party Internet server could access or maintain a database of available parts or provide routing for contact information between interested buyers and sellers and provide a centralized source of maintenance information.

Guidelines for Creating a Nationwide Exchange System

Creation of an Internet-based transit maintenance communications system requires several steps:

- Developing upper-level policy and management support, including adequate planning and budgeting, for enhanced communications and efficient and cost-effective use of emerging technology.
- Providing training, information, and hardware and software connectivity to participating facilities.
- Laying groundwork ("ramping up") for the Information Superhighway by implementation of Internet-compatible computer communications and document preparation protocols and integrating these functions with existing transit agency MIS systems and structures.
- Setting up Internet and internal Intranet host sites and systems for information exchange within and among properties.
- Developing agency policies on the use of the Internet for maintenance information sharing and exchange, including transactions involving the purchase of new or surplus parts, the exchange of spare or pooled parts, or joint purchasing of parts or services.
- Developing industry standards and relationships for purchasing or exchanging parts or other maintenance needs on the Internet.

- Promoting the information exchange network to transit agencies and manufacturers, suppliers, service providers, and the public to achieve critical mass in usage to gain the benefits of economy of scale and scope.
- Gaining the confidence of maintenance, purchasing, and overall managers in Internet-based communications systems and modern information technology advances.
- Rewarding and encouraging innovation in applying the new technology to existing agency problems and operations.

CONCEPT AND INNOVATION

Under-Utilization of Internet Technology

Maintenance of both rail and bus fleets among public rapid transit agencies is nearly always an in-house function with little coordination with like properties. A number of transit agencies publicize their agencies over the Internet, but they do not use the Internet to share maintenance information with each other. The Internet provides wider communication capabilities within and among these properties.

By using the Internet, local and wide-area computer networks, and other digital communication systems using standard Internet-compliant protocols, transit properties could achieve cost savings in retrieval and dissemination of up-to-date management and operational information in real-time on:

- contracts,
- safety issues,
- toxic substance handling,
- environmental regulation and protection,
- staff training,
- maintenance procedures,
- parts and system specifications,
- parts pricing and availability,
- joint parts or equipment purchasing,
- a greatly expanded spare parts base, and
- improvements in other areas related to maintenance.

Many organizations already make operational and technical knowledge bases available on the Internet. Companies in high technology, aviation, and other industries, including ground and air transportation, have Internet sites providing information on the sale of new, surplus, and used equipment and parts and related services. As the Internet grows, transit agency suppliers are beginning to make such information available on product availability, pricing, specifications, use, and performance.

Unrealized Potential Inventory and Procurement Cost Savings

Currently, the different transit agencies we have studied maintain spare parts inventories ranging from $1 million to $5 million. There is no official system for exchanging information and parts with other transit agencies. Thus, each agency currently spends 3% to 5% of its budget on maintaining large spare parts inventories, rather than pooling information and resources with other agencies to keep costs down.

As vendors provide product and pricing information and on-line parts and equipment purchasing, those agencies that are able to take advantage of these offerings will be able to achieve labor and cost-savings by eliminating overhead associated with procurement through intermediary distributors and retailers. The sooner that public transit agencies adapt their technical and managerial systems to take advantage of this development, the greater the savings they will achieve.

Getting Agencies on the Information Superhighway

None of the transit agency maintenance departments we have studied had a modem with an agency-sponsored Internet connection. We demonstrated that connection to the Internet can be made easy and cost-effective, and we believe that our project has introduced some participating agency managers to the potential benefits of using the Internet.

IDEA PROJECT INVESTIGATION AND PROGRESS

Our primary objective was to demonstrate a seamless interface through the World Wide Web and electronic mail between the participating agencies so they could:

- Make general information requests to each other.
- Use the Transpo.NET website to access a parts database and then request loans or exchanges of specific parts from each other.

The Three Stages of the Study

Stage 1: Collect and synthesize maintenance information available from but not limited to Metropolitan Transportation Commission (MTC), Bay Area Rapid Transit (BART), San Francisco Municipal Railway (SF Muni), San Mateo County Transit (SamTrans), Contra Costa County Connection, and Santa Clara Valley Transportation Authority (VTA). Select appropriate sector of management information for improving communication between the agencies and for inputting and accessing maintenance data.

Stage 2: Discuss the layout of the proposed communication system with transit managers and obtain feedback for improving the system features. Design the Transpo.NET system architecture. Prepare for trial system testing focusing on maintenance inventory data as a sample. Review test results with a panel of representatives from participating transit agencies and other users. The group of representatives was selected by the investigator and approved by the IDEA office. (See attached list of representatives at end of report.)

Stage 3: Perform pilot tests and obtain feedback from users. Re-assemble the panel of representatives to review results and develop guidelines for nationwide implementation of the system by transit agencies. Two Internet-capable terminals were installed at SamTrans (San Mateo County) and AC Transit (Alameda County) for testing and performing a demonstration.

Scope of the Study

Of the 25 transit agencies within the greater San Francisco Bay Area, this study focused on maintenance support offices in several bus transit agencies where cooperation was greatest. Although the initial efforts did not encompass the entire Bay Area, follow-up work could expand the scope to include the remaining transit agencies. After an operating Bay Area system is in place, the next step could be expansion to the entire state of California (approximately 100 additional transit agencies) and then nationwide.

SF Bay Area Public Transit Demographics

- One heavy rail transit system: BART
- One railroad commute line: CalTrain (SF Peninsula)
- Three light rail transit agencies (including Sacramento and San Jose)
- 22 bus agencies
- Market size: 6 million people in an area 100 miles (North-South) by 30 miles (West-East).

After an initial survey of Bay Area agencies (Stage 1), the study developed an Internet website called Transpo.NET (http://www.transpo.net) as a central information source focused on the sale or exchange of parts among agencies to test the design of a simple system. Participating agencies were offered standalone Internet terminals (WebTV set-top boxes and pre-configured Internet access and functional software) that were independent of existing agency computer systems (Stage 2) to demonstrate the feasibility of connecting transit agency maintenance offices. This model was tested and demonstrated to maintenance managers, and their comments and suggestions were obtained (Stage 3).

System Architecture for Pilot Project

Within a transit agency, the spare parts database is usually accessed over an Ethernet link using personal computer networks or a terminal on a mainframe system. When a designated person accesses these data, he or she is required to enter an ID and password. Only personnel within certain departments are allowed this privilege: purchasing, storeroom, maintenance, finance and administration. Some maintenance managers were not on computer networks within their own organizations.

Since this pilot project did not have direct access to installed agency computer systems and parts databases, we decided to test the concept by placing our Internet connection hardware physically close to existing agency computer terminals so that the operator could easily access both. We provided those managers who were willing to participate in testing the system with dedicated Internet computers (WebTV systems) with installed software and Internet access accounts. The pilot project hardware configuration is illustrated in Figure 1.

Incompatible Management Information Systems (MIS)

We surveyed the MIS systems at several transit agencies and found that there is a lack of standardization among hardware and software configurations. Several projects are now working on developing standards for transit system software and hardware to deal with this industry-wide problem. The lack of standardized database system software hampers the ready access and exchange of information between agencies.

The Parts Exchange Process

Concentration on Components As a result of meetings with transit agency personnel, we decided to concentrate the pilot study on parts that are common to all bus operators — such as bearings. Transit agencies use several hundred different types of bearings.

Parts Exchange Since the agency systems and existing parts databases were not configured for Internet access and there are security issues in gaining such access, we developed a database of bus bearings parts common to local transit agencies along with associated stock part numbers used by major Bay Area agencies and their suppliers. For example, if one agency needs a bearing that is out of stock, they could reference the database to determine if any of the other participating agencies have them in stock. We developed a Parts Exchange Bearings Reference Table that cross-references each bearing by all of its part numbers, so that transit agencies could readily share information about parts availability. We posted a table based on these data on our website.

Starting conditions The transit agency computer operator logs on to the Internet using the WebTV equipment or other Internet access means and goes to the Transpo.NET website using his keyboard or remote control.

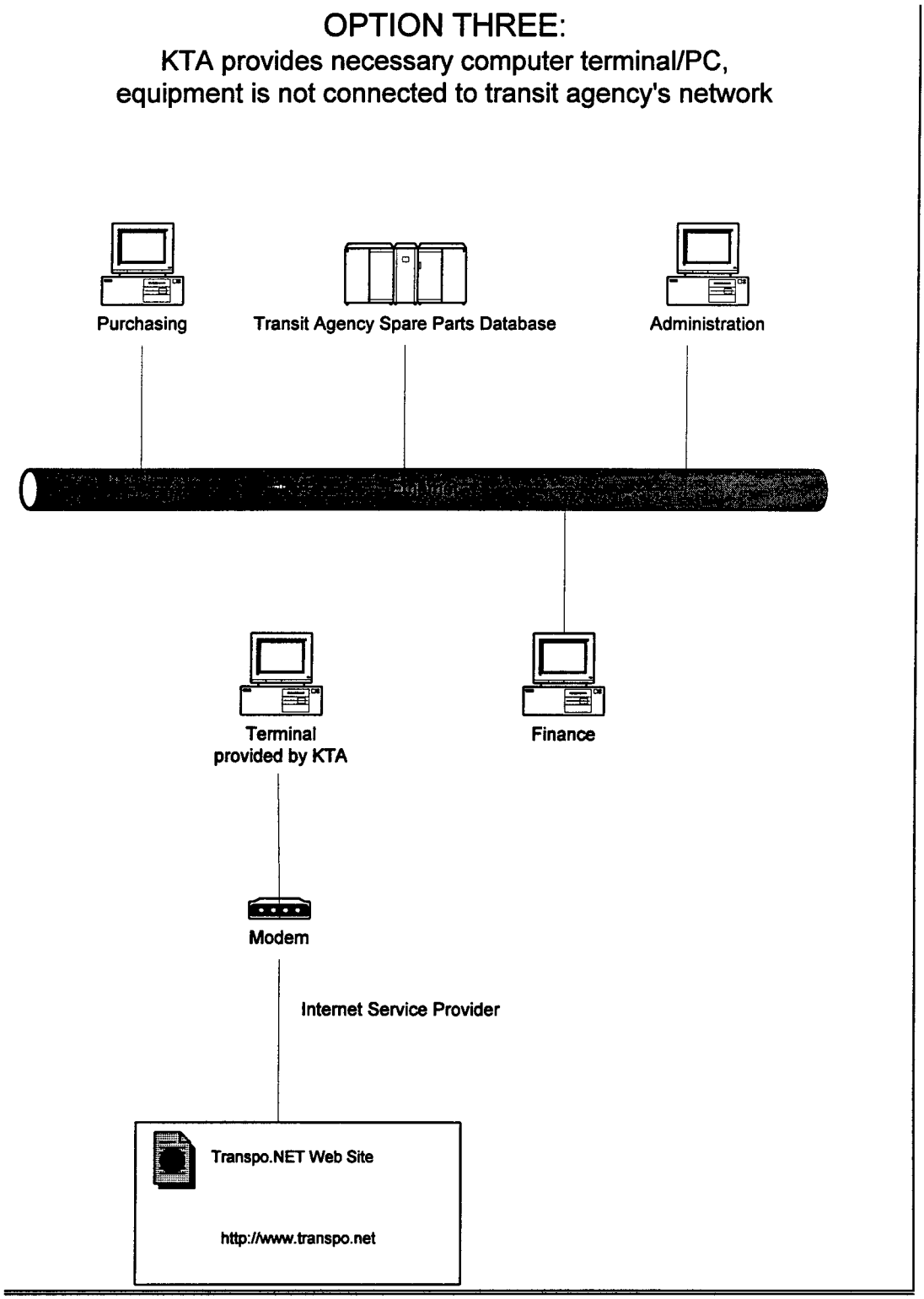

FIGURE 1 Pilot project hardware configuration.

Once at the Transpo.NET parts request form page or demonstration bearings table page, the user is required to enter an name and associated password. Once access has been approved (automatically by comparison to a preconfigured password access list), there are several choices presented to the user:

- request a bus bearing part,
- request a part by description, or
- send an e-mail to one of the other participating agencies for informational purposes.

The parts request process is illustrated in Figure 2.

Assembling the Bus Bearings Database Compiling parts number information on the 100 types of bearings used in the pilot program proved to be more difficult than anticipated. Many agencies cooperated on a limited basis, but since there was no budget for them to participate in this project, it received a low priority for their time and cooperation.

Non-standard Part Numbers There is no standard system for assigning part numbers to bearings. Not only do part numbers vary from agency to agency, but also from manufacturer to manufacturer. One single size or type of bearing can have as many as 25 different part numbers. This makes it difficult for agencies to share parts resources effectively without enhanced information exchange.

Assembling Other Databases Compiling entire spare parts inventories into relational databases is very time consuming and expensive. However, this is not a technical obstacle, but one of management and financial priorities. Eventual implementation of a bar-code inventory scanning system could help automate the process.

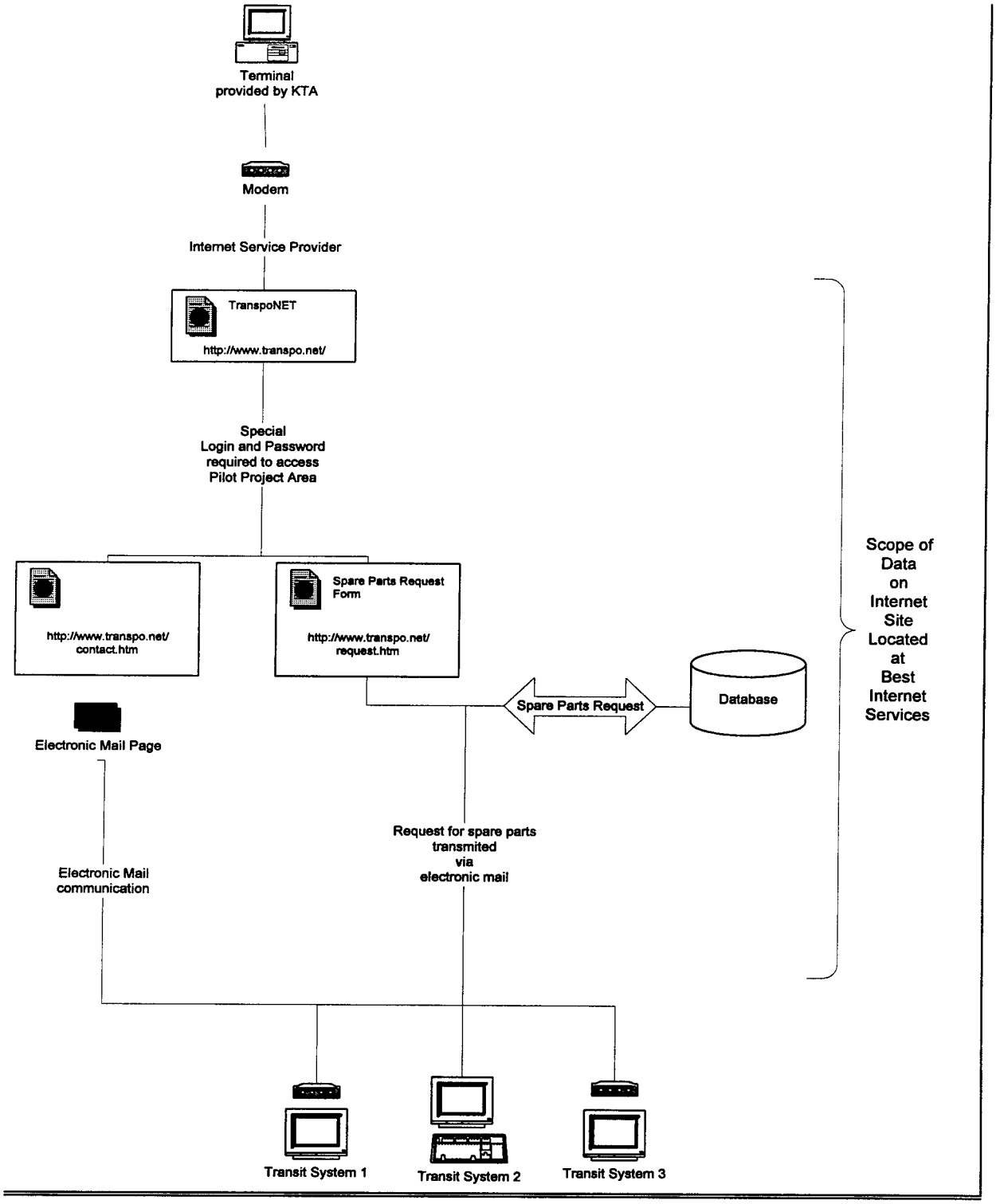

FIGURE 2 Parts exchange process.

Internet Access, ISPs, and the WebTV 1

We evaluated several alternatives for providing Internet access for agencies during the pilot phase of the project and decided to go with WebTV network computer hardware with fully configured software and Internet access subscriptions. We supplied the Internet connection hardware to the two transit agencies which agreed to participate actively in the project. Using the WebTV network as an Internet Service Provider, the agencies are able both to access the World Wide Web for information and to use electronic mail to communicate with each other.

The WebTV Internet terminal is a simplified personal network computer with a remote control (in lieu of a computer mouse), a computer keyboard (which can be connected to the main unit by wire or infrared transmission), and a television monitor for text and image display and sound.

While the WebTV is a consumer device designed and marketed for home use on a television set instead of a more expensive computer, it is a precursor to "thin client" network computers which may be the predominant model for office and network computing in the future.

Hardware Placement We developed a straight-forward and simple agreement for placement of the WebTV devices with participating agencies in the pilot project:

- documenting the loan of the equipment,
- establishing the purposes for the equipment and its proper uses,
- addressing liability for accidental or deliberate damage or loss,
- securing ownership, and
- establishing terms for its retrieval.
- The Transpo.NET Website (www.transpo.net)

Website Establishment We established an Internet website for the purpose of testing the parts exchange function. The Transpo.NET website illustrated a vital component of Internet communications. A website acts a central point for information access and exchange. By pointing and clicking on graphic icons or lines of text, a visitor to the site can jump to specific pages containing information, launch an e-mail program for transmitting a message to a designated addressee, or download a data or program file. The Transpo.NET website went on-line at the Uniform Resource Locator (URL) address *http://www.transpo.net.*

Website Design There are technical, business, and legal issues involved in a website design involving development of computer graphics, document coding for text display on the WWW, and programming to track and monitor access to the website. The text, visual images, and layout on a website are subject to copyright, trademark, and other intellectual property laws, and they must be created specifically for a site or used with permission or under license from the copyright or trademark owner. Selection and promotion of the website and its Internet address or URL must be done consistent with trademark and other trade regulation laws.

Website Administration Maintenance for large or complex websites can be time consuming and expensive, especially if it involves updating links to internal databases or other Internet sites. The information on a site must be attractive, easy to use, accurate, and timely. A website loses its usefulness as a resource or means of communication if people do not visit or use it.

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1 See Appendix A for a discussion of Internet hardware and software and access issues.

The Transpo.NET website was configured to include pages that advertise the Transpo.NET concept and provide information or other options to visitors to the site. Web page topics include:

- What is KTA,
- What is Transpo.NET,
- Parts Exchange (a sample page is viewable, but true access is password controlled),
- Parts Exchange Bearings Reference Table (password required),
- NAS Project (includes phase progress reports),
- Contact Page (visitors to the site are invited to e-mail their comments to KTA),
- Terms & Conditions for Site Use, and
- Transit Related WWW Links (See Appendix B);

Examples of Possible Additional Functions

- additional links for websites of suppliers and manufacturers,
- a bulletin board to post surplus parts to sell or exchange,
- list of e-mail addresses of participating agency personnel,
- hazardous waste disposal information exchange,
- contact information on other transit equipment suppliers, and
- a bulletin board to post safety issues, etc.

Website Terms of Service Access to restricted information on the website was governed by formal notice of terms and conditions:

- clarifying the relationship between the user and the information provider,
- setting limits on users' rights in participating in the pilot project web presence,
- disclosing risk and securing consent to sharing some identifying information with other website participants,
- defining the relationship between the website and linked external information sources and disclaiming responsibility for or association with information found off the Transpo.NET website,
- giving notice of intellectual property rights of others on the Internet,
- expressly disclaiming all warranties for information or other performance of the website and disclaiming all liability that might arise from use of the website or the Internet, and
- addressing user obligations in being granted a password for site access.

Password Protection and Transaction Security Access to the Transpo.NET website database table was restricted by a password system relying upon a simple Common Gateway Interface (CGI) program script compatible with leading WWW browser software. Establishing actual financial transaction capability would involve hosting the website on a secure Internet server and licensing encryption technology to prevent unauthorized interception or access to financial data.

Broadening Exposure The Transpo.NET website has been listed in the databases of the major Internet WWW search engines. We took additional steps to increase exposure including contact with other website administrators. An exchange of links with other websites is a widely accepted means of establishing formal and informal relationships on the WWW and enhances the reference value of a site.

Because of limited participation by managers at participating agencies, full implementation of the system with e-mail exchange and interactive queries of a dynamic real-time database were not possible. The technical feasibility of the architecture and limited functionality were demonstrated.

Establishing Agency and Business Relationships

We have encountered several complexities in bringing the Internet to transit maintenance agency offices, including:

- establishing rapport with and gaining acceptance by entrenched agency managers;
- business issues in forming relationships with web-hosting services, site designers, programmers, and other vendors;
- technical capabilities and limitations of the hardware configurations;
- appropriate and available telephone lines for hardware connections;
- Internet document display and communications formatting issues;
- legal implications in website design and promotion, business relationships, hardware placement, and project participation.

Management Reluctance Transit agencies managers are cautious about implementing Internet communications access, in part, due to concerns about protecting the security of their computer and communications systems, confidential or proprietary information, and their reputations with the public. They need to have confidence in the technology and the people who are offering Internet access and in their motives.

Corporate Policies The rapid growth of the Internet has out-paced many organizations' operating policies and procedures for computer use and digital communications. Organizations need to keep policies current to promote and regulate access to and use of the Internet consistent with institutional goals and interests. Policies should be developed on budgeting, standards for work-related uses of the Internet, regulation of computer access to confidential data and systems, promotion of the agency's operations and goals through efficient use of technology, and other issues.

Business and Technical Infrastructure The purchase of components and equipment relies upon established, formal agency procedures. The exchange of transit components now relies upon informal relationships between agency personnel. Formal financial structures and agreements will be needed before agencies may engage in similar commerce through the Internet.

Participant Questionnaire And Interview2 Participating managers have been surveyed about the performance of their maintenance programs and departments, cooperation with other agencies, and concept of networked information sharing before and during this study. To obtain feedback from the test phase, a second questionnaire was designed to get more specific information about general computer and Internet literacy:

- prior experience with the Internet and electronic communications,
- experience of and reactions to the WebTV device and website,
- any independent access to the Internet from home or other sites,

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2 See Appendix C for more detail on managers' responses to the pilot project.

- use of e-mail and other Internet-based communications, and

- opinions on or suggestions for policies or technical capabilities.

We demonstrated the Transpo.NET website and available hardware options (PC and WebTV based Internet access) and solicited feedback from a meeting of purchasing and maintenance managers on their reactions and priorities for their use of Internet technology.

The maintenance managers had varying levels of familiarity with computer technology and the Internet. While individual managers recognize the capacity of improved communications to assist them in their work, they and their agencies lack the specialized expertise or resources to design applications or adapt systems for their organizations while meeting their immediate needs.

Middle managers are the most constrained in terms of time, money, and staffing. While they were not immediately willing to leap into developing a parts database or embrace Internet-based parts exchange, they were quite interested in using the Internet to reduce the time spent on the labor-intensive development of specifications and bid contracts.

Internet communications protocols and features offer many useful capabilities to agency personnel to enhance their work:

- The World Wide Web (WWW) allows for ready transmission of text, still and moving graphical images, sound files, and other computer data and programs.

- Electronic mail (E-MAIL) messages can be transmitted to individuals or broadcast to many users, and they may have data or program files attached.

- Automated e-mail mailing lists and electronic discussion groups (LISTSERVS) allow for dissemination of information to users with specific interests or expertise and give individuals and organizations wide exposure.

- USENET newsgroups allow individuals and organizations to post questions or read and respond to ongoing discussions of issues on specific topics and areas of concern.

- TELNET programs allow for log-on access to remote computers for information research or access to specialized computer programs or environments.

- File Transfer Protocol (FTP) software is capable of efficient transfer of large data or program files.

- The WWW browsers, undergoing rapid development and enhancement, integrate several communications features (including file transfer and other file communications) for use on Internet and Intranet systems, and they soon will incorporate or provide access to word processing and other office desktop applications.

- The Internet communications protocols and standards for document and image display, enabling communications across different computer platforms, offer advantages to agencies in improving internal operations, communications, and procedures. For example, information could be accessed on a maintenance shop floor through use of a touch-screen "kiosk" unit, and equipment availability and repair status could be checked in real-time by individuals in different departments.

PLANS FOR FUTURE IMPLEMENTATION

The research results from our pilot project suggest that implementation of Internet-based information sharing among agencies requires a two-pronged approach:

(1) regional, local, and individual agency policy direction from above to provide the organizational incentive to devote attention and resources to developing more efficient use of available technology, and

(2) leadership in implementation by a handful of progressive agencies to demonstrate the feasibility and practical means of using the Internet while creating competitive pressures on other agencies by serving as examples in cost savings and improved efficiency.

Someone must demonstrate that the cost and labor savings of using any new technology will have an immediate impact on the transit agencies' work. The successful application of the Internet at a few agencies will serve as a working model for others as well as providing the seed for development of a network of agencies meeting mutual needs.

We believe that the best way to do this is to work with agencies that have policy and political support to use new technologies and already perceive the advantage of digital communications. The San Francisco Bay Area, and the counties in the rapidly growing "Silicon Valley," offer a unique environment for furthering the development of electronic communications among agencies.

By working with two or three agencies, that are already using the Internet to promote their services in an environment where the Internet is a feature of daily life, we could develop a detailed model of how any agency could benefit from using Internet technology and share that model with other agencies that lack the expertise and resources to investigate this technology themselves.

Practical steps in these directions would include detailed analysis of the MIS structures and systems of a given agency, tracking advances in relevant hardware and software, and customizing these resources for transit maintenance needs, and promoting their use to those who would benefit most from them.

Further research and project development could have several stages of increasing complexity:

- A research study analyzing the MIS infrastructure and management needs of various agencies coupled with
    - ◊ on-going analysis of software and hardware developments in Internet computing,
    - ◊ research and analysis of other uses of the Internet to exchange similar types of information meeting similar needs, and
    - ◊ tracking and promotion of transit maintenance information propagation on the Internet.
- Providing assistance and guidance to transit agencies in accessing and utilizing Internet-based communications by coordinating the delivery of expertise in state-of-the-art hardware and software engineering to agencies **or**
    - ◊ Full development and installation of software and hardware connectivity systems in agencies along with providing the
        - * necessary training;
        - * a structure for the exchange and updating of specifications and drawings, bid contracts, or other maintenance information on secured Internet servers;
        - * a financial structure for parts exchanges and purchases on secured Internet servers;
        - * establishing virtual warehouse systems for pooling surplus, spare, or rarely used parts; and
        - * connection to suppliers of equipment, parts, and services.

Building on the NAS Transit-15 IDEA project results, initial coordination at the policy and agency level could take from three to six months, and within an additional six to twelve months for development of a well-documented system architecture that could be readily exported to other agencies and regions. Once several agencies establish a working system of communications, others will join to expand this network or reproduce that model to implement within their locality.

CONCLUSIONS

Public transportation is not a local industry; it is nationwide and ready for a model demonstrating the cost-saving, increased safety, and increased efficiency that global communication can promote. There is little question that the Internet will be a major feature of transit agency information operations in the future.

The main obstacle to transit agency use of the Internet is organizational. The immediate priority for transit maintenance management appears to be marshaling existing resources to save time, effort, and money. Individual maintenance managers strongly indicated their desire to exchange maintenance information more efficiently and save time and money, if the technical means and management support were provided to them. The positive response is tempered by the realities that maintenance managers, and even some agency MIS managers, do not have the technology, know-how, or management approval to use this emerging communications medium.

Implementation of Internet communications would transform the way managers and agencies communicate. Participation in electronic commerce requires addressing financial and organizational obstacles and adapting existing policies and procedures to new technical and financial opportunities and risks.

The challenge lies in getting individual agencies, currently burdened by limitations in staffing and expertise, and solely accountable to local government entities and constituencies, to gear-up to embrace new ways of communicating and doing business. The use of the Internet offers long-term benefits to transit agencies, but agencies need to perceive an immediate positive impact on reducing operating budgets. Moreover, there are few incentives for individual procurement or maintenance professionals to divert scarce time and resources to develop the necessary familiarity with the recent and rapid development in Internet technology and commerce.

Many state and local officials and transit maintenance managers and personnel have been very positive about the concept, but they are uncertain about how it will be accomplished. State and local policy officials indicated their willingness to support promotion and further development of the project concept if study results are favorable. Transit maintenance managers could immediately benefit from sharing information about part and system specifications, contract terms and conditions, planned purchasing, safety and maintenance procedures and manuals, and other operational issues and concerns.

Many agencies are too preoccupied with operations and hampered by their limitations to take the lead in developing a working Internet-based system, and there is little cooperation on such an operational level. Someone has to provide them with direction and the technical and other expertise required to deal with vital, but rapidly changing, technology.

It is better if the agencies help direct and shape the course of their Internet usage now. Delay will mean devoting time and resources later to catching up with the technology and adapting operations to a purchasing environment that has been determined by the dictates of purely commercial interests. If the private sector alone dictates the terms by which transit agencies use the Internet, current inefficient and wasteful practices will be repeated using the new technology. It is no advance to electronically order new parts, while other agencies sell the same parts as surplus metal.

Developing a rational system for public transit agency use of the Internet might require some level of industry-wide sponsorship or government intervention or support. Joint research and interagency cooperation would allow for development of a standardized system that could be implemented by a given agency with minimal risk or disruption. Just as the Internet developed from joining local networks together, transit agencies must prepare to employ the technology of the Internet and Intranet to meet their immediate local needs and expand their reach and capabilities beyond their local areas by developing and supporting joint endeavors in information sharing and exchange.

It is estimated that there is $400 million worth of spare parts located at the maintenance facilities of the transit agencies of the United States. We conservatively estimate that transit agencies could lower their inventory by 10% or $40 million if an Internet based maintenance information and part procurement and exchange system is implemented.

The project results indicate that a system to exchange maintenance and parts information over the Internet is feasible and being implemented in other industries today. *Critical mass*, the level at which there are enough transit agency participants for substantial benefits to materialize, did not come about during this pilot study. The study results are very promising, and we fully expect to see transit maintenance information exchange taking place over the Internet in the near

future. Two key questions are how soon it will be implemented and what influence public transit agencies will have on the process of shaping Internet-based transit maintenance information exchange.

APPENDIX A: INTERNET ACCESS AND ISPs

We evaluated both different means of gaining Internet access and varying hardware and software configurations for project sites. We decided that it was desirable to use one Internet access provider and uniform hardware and software configurations for all the sites throughout the project area in order to provide consistent data, to reduce the administrative and technical overhead, and to make the system easy for novice users with minimal training.

The project sites must have access to the Internet through one of the following

- direct Internet access through an installed computer system with registered Internet computer addresses,
- one of the on-line computer services (such as America OnLine, Prodigy, or CompuServe, etc.),
- an Internet Service Provider, or
- some other means.

It was not technically or economically feasible to provide an infrastructure for direct Internet, Intranet, or Wide Area Network access for the pilot project sites. The on-line services' consumer orientation and inherent technical limitations currently make them unsuitable even for the pilot project.

There are numerous Internet Service Providers (ISPs) in the San Francisco Bay Area. Access to their services can be readily gained through Point of Presence (POP) dial-up telephone numbers throughout the geographic scope of the pilot project. However there were administrative, technical, and financial burdens associated with establishing accounts and configuring software for reliable access for each of the pilot project sites. Even the best of the local ISPs have had difficulty because of their rapid expansion with dial-up access availability for ordinary accounts during peak hours. More reliable ISP service is available at higher commercial rates, but there are hardware and administrative burdens and limitations on obtaining reliable pilot project data.

Varying hardware and software configurations for different ISPs, or different POPs connecting to a single ISP, would add additional technical and administrative burdens, especially since ISPs often change their system connection specifications or configurations, and some of them experience dial-up connection difficulties due to fluctuating demand and expanding user bases at certain POPs.

SELECTION OF THE WEBTV FOR THE PILOT PROJECT

Connection software and a modem are required for dial-up access from a personal computer to an ISP, and a minimal system would include a color monitor and a soundcard and speakers for display of images and playing sound files from Internet sites. Such installed devices can be rendered nonfunctional if there are conflicts with other installed hardware or software. World Wide Web browser and e-mail reader software require individual configuration on systems. Keeping a system properly configured may be beyond the capabilities of computer users new to the Internet, especially in organizations where system administration is not done by the individual user.

We reviewed various hardware and software options for providing Internet access and selected a set-top Internet computer marketed as the WebTV for the pilot project. The WebTV is not a fully functional personal computer, but a dedicated Internet device that uses a television for graphics display and sound. A remote control (in lieu of a computer mouse) and a keyboard are used for input. The WebTV does not include a harddisk for storing extraneous software or downloaded images or text. The WebTV systems have all connection software installed and do not allow for user-modification of the system hardware or software.

WebTV provides Internet access POPs throughout the project area, and their hardware and software are preconfigured, with system updates downloaded and installed automatically from their central network. The WebTV system has a large infrastructure for dial-up connection and well-staffed technical support, in the event of a problem.

The WebTV hardware is uniform and relatively inexpensive, occupies little space which may be a premium in site offices, and requires little or no system administration. The device offered a complete solution and only one point of contact for support during the pilot project. The WebTV standalone units posed no security threats to transit agency computer systems.

The WebTV devices are easy to use with a reduced learning curve for e-mail and WWW uses. The installed software is licensed with the hardware device, so there is no need to purchase numerous software packages or obtain site licenses for software which is not under the physical control of the network administrator. Novice Internet users, who may only be familiar with mainframe or DOS computer systems would not have to learn a Windows software interface or how to launch Internet applications software.

This stable configuration prevent users from (1) altering software or hardware configurations which might render the devices inoperable through software or hardware conflicts, (2) installing unlicensed or extraneous software which would detract from achieving the project goals, or (3) downloading software or other unsuitable materials. No word processing or other capabilities that might distract users from their other assigned duties which might compromise agency cooperation.

While designed for a consumer market, the WebTV devices represent an advanced technology that may become the dominant model for Internet connectivity in the workplace. Leading computer hardware and consumer electronics manufacturers are designing and manufacturing different versions of such network computers for consumer and business markets.

APPENDIX B: INTERNET LINKS

The pilot project developed a short list of Internet links to government, university, professional association, and private industry supplier sites to demonstrate the Internet's capability of delivering information from diverse sources with minimal effort. Powerful search engines and comprehensive reference sites are already making detailed information easy to find on the Internet.

United States Department of Transportation

- US Dept. of Transportation (DOT) WWW Home Page
- DOT Federal Transit Administration (FTA)
- DOT Federal Highway Administration (FHWA)
- DOT National Highway Traffic Safety Administration (NHSTA)
- DOT Federal Railroad Administration (FRA)
- DOT Bureau of Transportation Statistics (BTS)
- DOT Bureau of Transportation Statistics (BTS) National Transportation Library (NTL)

National Academy of Sciences Transportation Research Board

- National Academy of Sciences (NAS) Transportation Research Board (TRB)
- NAS TRB Transportation Directories, Glossaries, and Other Internet Resources
- NAS TRB Government Transportation-Related Internet Site Links

California State & Local Transit Agencies

- State of California Home Page
- California Department of Transportation (CalTrans)
- California Office of Traffic Safety
- CalTrain Home Page
- Metropolitan Transportation Commission (MTC) Home Page
- Bay Area Transit Information Project
- The Golden Gate Bridge, Highway and Transportation District
- Golden Gate - Transit System Information
- AC Transit Home Page
- San Mateo County Transit District (SamTrans)
- Santa Clara Valley Transportation Authority
- SF MUNI - San Francisco Municipal Railway's "Lines on-line"

- Association of Bay Area Governments (ABAG) Home Page
- Sacramento Area Council of Governments (SACOG) Home Page
- SACOG - Transportation Index
- Southern California Association of Governments (SCAG) Home Page
- Los Angeles County Metropolitan Transportation Authority (MTA)

University Transportation Related Sites

- Princeton University - Directory of Transportation Resources
- MIT Center for Transportation Studies
- University of Florida Transportation Research Center
- Penn State University's Pennsylvania Transportation Institute (PTI)
- San Jose State University (SJSU) - Mineta Int'l Inst. for Surface Trans. Policy Studies
- SJSU Mineta IISPS Transweb - Transportation News Links
- Texas A&M University - Texas Transportation Institute (TTI)
- TTI TransLink

Professional Organizations

- American Public Transit Association (APTA)
- APTA Transit Resources on the WEB (by Alpha)
- APTA Transportation Providers
- Institute of Transportation Engineers
- American Association of State Highway Transportation Officials
- National Electrical Manufacturers Association

Manufacturers

- Rockwell International Corporation's Product Directory Page
- Flyer Industries Ltd. - New Flyer Buses (Winnipeg, Manitoba, Canada)
- Orion Bus Industries, Inc. - Oriskany, New York
- Consorcio "G" Grupo DINA/ Motor Coach Industries International (MCII)
- Volvo Bus Corporation (Sweden) Home Page (Press Releases only during site reorganization)

APPENDIX C: MANAGER RESPONSES TO THE PILOT STUDY

We had limited success in getting transit agencies to participate actively in our pilot project, although they expressed interest in the concept of exchanging maintenance information using Internet technology. We were only able to install two WebTV devices with transit agencies after six months of vigorous efforts to obtain equipment placements. We were able to demonstrate the use of the Transpo.NET project concept to some managers who had not accepted WebTV connections to the Internet.

We met with a regularly assembled committee of regional maintenance managers and demonstrated the Transpo.NET website and available hardware options (PC and WebTV based Internet access) and solicited feedback from the attending managers on what would be their priorities for their use of Internet technology. The demonstration included, in part:

- a review of the bus bearings table displaying the stock numbers of common bus parts used by different transit agencies and bus manufacturers at a single source (Transpo.NET website)
- the advent of bus manufacturers' sites on the WWW (e.g., Orion Bus Industries, Inc.; Flyer Industries Ltd.; and Volvo Bus Corporation) along with those of other manufacturers (e.g., Rockwell International Corporation)
- websites devoted to the sale of surplus aviation and other parts (e.g., www.spec2000.com; www.findparts.com).

We distributed a questionnaire soliciting information about the managers' familiarity with computer systems in general, our demonstration, and the Internet. In addition, we participated in a lively discussion about the project. The managers reaffirmed several preliminary findings:

- lack of standardization of industry fleets in local areas;
- the "purchasing manager" position that there are no "spare parts";
- the viewpoint that purchase of new parts directly from manufacturers was often an easier alternative to parts exchange with other agencies;
- that an informal telephone based exchange system could meet other localized needs;
- budgetary restraints on adding additional staff to implement computerization or tracking of parts inventories; and
- agency action might follow the manufacturers onto the Internet* .

Several managers were very responsive to the concept of sharing of information through the Internet, especially

- the labor-intensive development of specifications and bid contracts
- other maintenance procedures including the management and disposal of toxic waste.

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* One manager was visibly shocked when he mentioned a manufacturer, and we were able to display, instantaneously, that manufacturer's web site and show that the supplier had already established a presence on the Internet that included an incipient "parts page."

The managers were frank about their limitations in contributing to such a system as maintenance and purchasing managers. Several managers recommended that we work with

- industry associations such as the American Public Transit Association (APTA),
- management with authority to direct policy, and
- agency Management Information Systems (MIS) personnel in further developing and implementing an infrastructure.

The difficulties in obtaining agency sponsorship from middle-level management who are facing daunting limitations on staff and resources, and the technical limitations in implementing a multi-agency system without the existence of a "critical mass" of part suppliers and transit agencies has led us to reevaluate the best means for developing a system that meets the agencies' most pressing needs while positioning them to take advantage of the emerging commerce on the Internet.

It was anticipated from the inception of this project that the aforementioned committee of regional maintenance managers would post review the end product, but such post review was rejected. To meet the contractual objectives of information dissemination, contact was made with the California Transit Association which published a synopsis of the project and product in the June/July 1998 edition of its trade magazine, Transit California. Also, State Senator Quentin L. Kopp, Chairman of the Senate Transportation Committee has been supportive of this project in concept. Senator Kopp's staff has recommended to further sources of funding, both state and local. Letters of endorsement of the concept have been received from members of the American Railroad Engineering Association and from persons associated with the University of California, Berkeley.

At present KTA is entering the second phase (see Appendix D) that will result in a demonstration model of and a guidebook to the Transit 15 Internet Information Sharing System. This resulting model will then be available for inspection and evaluation to appropriate agencies nationwide.

President Clinton's announcement of February 12, 1997 of his intention to designate a chairman to the "Advisory Committee on High Performance Computing and Communication, Information Technology and the Next Generation Internet" was directed to accelerate development and adoption of information technologies that will be vital for American prosperity in the 21st century. Could there have been a more supportive national climate for the purposes of our Transit-15 project? Yet, as mentioned above, the Regional Transit Coordinating Purchasing Group on April 17th, 1997(which was to review our product) unexpectedly withdrew their cooperation. This rejection was not entirely a reflection of their position on the merit of our proposal since earlier support had been offered.

Our familiarity with the transit participants lead us to believe the "rejection" was the result of management time and budget constraints; demands of daily operations and need for further education to raise their comfort level when dealing with the new technology and it's effects on their job.

These considerations have led us to make the proposal for Phase II that is presented in Appendix D. We also believe that the publication of the synopsis of the Transit-15 project in the CTA trade magazine, *Transit California,* June/July, 1998, will publicize the project and elicit interest and participation from transit managers in California and other state transit agencies.

APPENDIX D: PILOT STUDY, PHASE 2 (TRANSFER OF RESULTS)

INTERNET INFORMATION SHARING FOR TRANSIT MAINTENANCE: A PILOT STUDY, PHASE II

Concept and Innovation

By using the Internet, local and wide-area computer networks, and other digital communication systems using Internet-compliant protocols, transit properties could achieve cost savings in retrieval and dissemination of up-to-date management and operational information on contracts, safety issues, toxic substance handling, environmental regulation and protection, staff training, maintenance procedures, parts and system specifications, parts pricing and availability, joint parts or equipment purchasing, a greatly expanded spare parts base, and improvements in other areas related to maintenance.

Different transit agencies maintain spare parts inventories, but there is no system for exchanging information and parts with other transit agencies. As vendors provide product and pricing information and on-line parts and equipment purchasing, those agencies that are able to take advantage of these offerings will be able to achieve labor and cost-savings by eliminating overhead associated with procurement through intermediary distributors and retailers. We demonstrated that connection to the Internet can be made easy and cost-effective.

Phase I

A system architecture to share maintenance information between transit properties through use of the Internet and World Wide Web (WWW) was designed and trial tested, and guidelines were developed for adoption of basic and enhanced systems by transit maintenance facilities. The system design allows for retrieval of information from relational databases on parts held by transit rapid transit agencies for sale, exchange, or sharing with other properties. An Internet website was designed with the capability of querying a prototype database of bus bearings parts commonly used by major transit agencies in the San Francisco Bay Area.

The website also provided access to Internet resources relevant to transit maintenance functions and demonstrated the ability to send electronic mail (e-mail) and to submit text comments using an easy-to-use graphic user interface. Low-cost, standalone Internet connection hardware with pre-configured and installed software which require little systems administration was provided to participating maintenance managers. The technical feasibility of developing a nationwide parts exchange system has been demonstrated.

After an initial survey of Bay Area agencies (Stage 1), the study developed an Internet website called Transpo.NET (http://www.transpo.net) as a central information source focused on the sale or exchange of parts among agencies to test the design of a simple system. Participating agencies were offered standalone Internet terminals (WebTV set-top boxes and pre-configured Internet access and functional software) that were independent of existing agency computer systems (Stage 2) to demonstrate the feasibility of connecting transit agency maintenance offices. This model was tested and demonstrated to maintenance managers, and their comments and suggestions were obtained (Stage 3).

Since this pilot project did not have direct access to installed agency computer systems and parts databases, we decided to test the concept by placing our Internet connection hardware physically close to existing agency computer terminals so that the operator could easily access both. We provided those managers who were willing to participate in testing the system with dedicated Internet computers with installed software and Internet access accounts. Using the WebTV network as an Internet Service Provider, the agencies are able both to access the WWW for information and to use electronic mail to communicate with each other.

We developed a database of bus bearings parts common to local transit agencies along with associated stock part numbers used by major Bay Area agencies and their suppliers. We developed a Parts Exchange Bearings Reference Table that cross-references each bearing by all of its part numbers, and posted a table based on these data on our website.

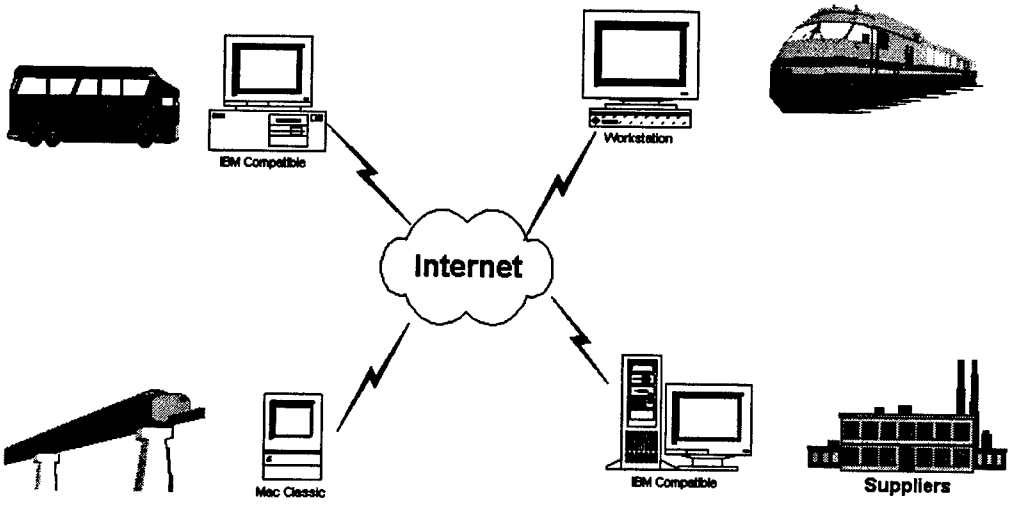
Phase I Conclusions

Phase I demonstrated that transit maintenance managers could immediately benefit from sharing information about part and system specifications, contract terms and conditions, planned purchasing, safety and maintenance procedures and manuals, and other operational issues and concerns.

Phase I also demonstrated that the challenge lies in getting individual agencies, currently burdened by limitations in staffing and expertise, and solely accountable to local government entities and constituencies, to invest limited resources in new ways of communicating and doing business. Moreover, there are few incentives for individual procurement or maintenance professionals to divert scarce time and resources to develop the necessary familiarity with the recent and rapid development in Internet technology and commerce. The use of the Internet offers long-term benefits to transit agencies, but agencies need to perceive an immediate positive impact on reducing operating budgets.

Many state and local officials and transit maintenance managers and personnel have been very positive about the concept, but they are uncertain about how it will be accomplished.

Joint research and interagency cooperation would allow for development of a standardized system that could be implemented by a given agency with minimal risk or disruption. Just as the Internet developed from joining local networks together, transit agencies must prepare to employ the technology of the Internet and Intranet to meet their immediate local needs and expand their reach and capabilities beyond their local areas by developing and supporting joint endeavors in information sharing and exchange.



The Future

The technical feasibility of developing a nationwide parts exchange system has been demonstrated. Transit Properties could rely upon existing computer resources from within their organizations or purchase inexpensive desktop personal computers or the new "thin client" network computers to access the Internet to exchange maintenance information, including parts availability and pricing.

Connections to the Internet could be through an agency's existing network behind appropriate "firewall" security or through an "air-gap" standalone system, not connected to any agency systems. A third-party Internet server could access or maintain a database of available parts or provide routing for contact information between interested buyers and sellers and provide a centralized source of maintenance information.

The research results from our pilot project suggest that implementation of Internet-based information sharing among agencies requires a two-pronged approach:

- and leadership in implementation by a handful of progressive agencies to demonstrate the feasibility and practical means of using the Internet while creating competitive pressures on other agencies by serving as examples in cost savings and improved efficiency.

Our original plan for Phase II of this study was to implement a spare parts database where agencies could buy, sell, or trade their spare parts. We found that the industry was not yet ready for this detailed involvement. "There was fear and loathing in the market place". As a result we have redefined Phase II.

Phase II

The evaluation of Phase I led us to conclude that transit managers needed more information and more education about Internet-based information sharing at both the concept level and the detail level. As a result, Phase II was redefined as follows:

- Develop an *Introductory Guide to the Internet for Transit Managers* giving a fairly detailed overview of the benefits, capabilities, restrictions, potential, and hardware and software requirements of the Transit 15 Internet Information Sharing system.

- Create a demonstration system at a small transit agency in the San Francisco Bay Area.

The Guide

The guidebook will be designed to give useful, practical information to interested transit manager who are considering or planning the implementation of an Internet-capable system at their facility, including the following:

- Use of the Internet in industry
- Typical costs and time for installation
- Security, Encryption, and Firewalls
- Samples of typical installations
- Legal questions to address
- Benefits to expect
- How to get started
- Connecting through an ISP
- Terms used in Internet system design
- Resources including:
- Vendors
- Legal
- Federal and State Programs and Grants
- Internet and World Wide Web Resources

The Demonstration System will be set up at a small transit agency in the San Francisco Bay Area and available to interested transit personnel.

Conclusion

The main obstacle to transit agency use of the Internet is organizational. The immediate priority for transit maintenance management appears to be marshaling existing resources to save time, effort, and money. Individual maintenance managers strongly indicated their desire to exchange maintenance information more efficiently and save time and money, if the technical means and management support were provided to them. The positive response is tempered by the realities that maintenance managers, and even some agency MIS managers, do not have the technology, know-how, or management approval to use this emerging communications medium.

Implementation of Internet communications would transform the way managers and agencies communicate. Participation in electronic commerce requires addressing financial and organizational obstacles and adapting existing policies and procedures to new technical and financial opportunities and risks.

Most agencies are absorbed with daily operations and too limited by time and budget constraints to take the lead in developing a working Internet-based system. Yet it is better if the agencies help direct and shape the course of their Internet usage now. Delay will mean devoting time and resources later to catching up with the technology and adapting operations to a purchasing environment that has been determined by the dictates of purely commercial interests. If the private sector alone dictates the terms by which transit agencies use the Internet, current inefficient and wasteful practices will be repeated using the new technology. It is no advance to electronically order new parts, while other agencies sell the same parts as surplus metal.

Developing a national system for public transit agency use of the Internet might require some level of industry-wide sponsorship or government intervention or support. Joint research and interagency cooperation would allow for development of a standardized system that could be implemented by a given agency with minimal risk or disruption. Just as the Internet developed from joining local networks together, transit agencies must prepare to employ the technology of the Internet to meet their immediate local needs and expand their reach and capabilities beyond their local areas by developing and supporting joint endeavors in information sharing and exchange.

It is estimated that there is $400 million worth of spare parts located at the maintenance facilities of the transit agencies of the United States. We conservatively estimate that transit agencies could lower their inventory by 10% or $40 million if an Internet based maintenance information and part procurement and exchange system is implemented.

APPENDIX E: ARTICLE APPEARING IN *TRANSIT CALIFORNIA*, JUNE/JULY, 1998

Transit Looks to Cut Costs Online

By: Victor Kiernan and Pat Cannon

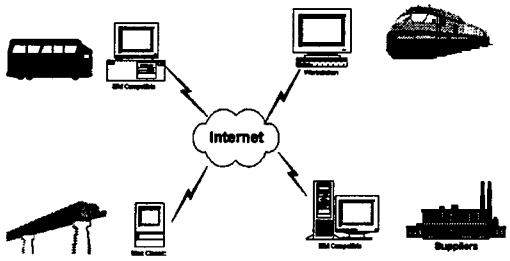
Mr. Kiernan is the owner of Kiernan Transit Associates in Lafayette, California, and Mr. Cannon is the Manager of Maintenance Support Services for AC Transit in Oakland, California Kiernan Transit Associates (KTA) with the support of the Metropolitan Transportation Commission in Oakland is developing a system that uses the world wide web as a low-cost powerful tool to increase efficiency and make possible cost savings for public transit agencies for ground transportation. With additional financial support the finalized version is expected to be available for commercialization by the fourth quarter of 1999. The original proposal submitted by KTA to the IDEA Program of the Transportation Research Board (TRB)/National Academy of Sciences (NAS) was sponsored from a Federal DOT fund as the Transit-15 Contract. A prototype system was implemented under the IDEA Program funding and a final report of this study is available on request.

The major advantage of using this system will be the reduced costs in making parts purchases from suppliers over the Internet. A savings of 80% per purchase order is estimated when using the e-commerce feature included in this system. Additional cost savings benefits could be the lowering of inventory requirements. This could be accomplished by both more efficient purchasing methods and the exchanging of needed parts between similar transit operators. Other benefits include identifying common safety issues, disposal of hazardous wastes and sale of surplus equipment. Sharing of maintenance records and life expectancy of parts could result in more dependable, efficiently run systems with improved safety and convenience for passengers. Manufacturers' decisions regarding parts design, availability, and problem resolution could be influenced.

The original concept for Transit-15 started in the mid-80's. During this period a survey was conducted of transit agencies and their maintenance managers throughout the eastern United States and in the San Francisco Bay Area. In 1995 KTA became convinced that the Internet was the perfect communication vehicle for implementing this system.

AC Transit in Oakland, California participated in an initial test of the Transit-15 system. Pat Cannon was supplied with a terminal to allow access to the Internet and the central Website Transit-15. This configuration allowed e-mail dialogue between agencies and connection to transit equipment suppliers and other related transit sites. In conjunction with this, meetings were held with the members of the Transit Maintenance Committee of the Regional Transit Coordinating Council to explain the concept of Transit-15 to them. Additional assistance was received from San Francisco Muni and Central Contra Costa Transit Authority to build up a database of bus bearings to be included in the Website. A questionnaire was designed and distributed to all participants for the purpose of determining their present use of computers and their information exchange needs.

At present, KTA is seeking additional participants as it enters its second phase, which is expected to result in an advanced prototype system and demonstration model in the San Francisco Bay Area. This resulting model will then be available to appropriate agencies nationwide.



LIST OF PARTICIPATING TRANSIT MANAGERS

GOLDEN GATE TRANSIT

Len Gaskell

Dwight E. Goff, Maintenance Manager

James O'Hare, Director of Information Systems

AC TRANSIT

Pat Cannon, Manager of Maintenance Support Services

Ed Burrows, Materials Superintendent

Marshall Seavey, Purchasing and Materials Department

Joe Kuchen, MIS Manager

Glen Andrade, Materials Manager

SAMTRANS

Herbert D. Atkins, Computer System Administrator

George Fulscher, Manager Materials

Chuck Harvey, Bus Maintenance Contract Administrator

Jim Castagnio

CONTRA COSTA COUNTRY CONNECTION

Scott Mitchell

Walter Peckham, Buyer

Scott Pebahouse, Storeroom

SAN FRANCISCO MUNI

Debra Weil Denison, Manager Systems Development

Wayne W. Gerstenberger, General Superintendent Equipment Maintenance Admin.

Charles E. Kalb, Materials Manager Maintenance Division

Lee Large, Maintenance Manager

INVESTIGATOR PROFILE

PRINCIPAL INVESTIGATOR

Victor D. Kiernan is a registered professional engineer in California (Control Systems) with a total of thirty-five years of experience. Mr. Kiernan is a graduate of the University of California, Berkeley (1951) with a BSEE in electrical engineering. For twenty years he has held various positions in systems design and testing in the aerospace field, manufacturing, and research and development. For over fifteen years, he has been was employed in the transit field as a senior electrical engineer, train control engineer, and safety engineer.

Mr. Kiernan has been close to the maintenance function in many of these assignments. While at SF Muni, he designed a maintenance system for all fixed facilities within Muni. In 1983, he was the first to propose the implementation of a maintenance information system similar to Transpo.NET and presented three American Public Transit Association papers on the subject.

CONTRIBUTING SOFTWARE ENGINEERING CONSULTANT

Peter Lazarus holds a B.S. degree from Rensselaer Polytechnics; a Master of Science and Doctorate degrees from Yale University. He has over thirty five years of industry and scientific experience in the areas of industrial information processing systems including research, development and management; product development manager, engineer/programmer for more than five generations of direct access storage products. His areas of specialization are MVS subsystem product development, DB2 design, code, build, test, release, and customer support; VTAM distributed processing application design and others. He has developed process management and planning systems, field support and maintenance for main frame applications and information theory researcher for numerical analysis and nuclear physics models.

CONTRIBUTING BUSINESS AND TECHNOLOGY CONSULTANT

Michael D. Barry studied and worked in social and natural science research and mathematics at Harvard University, where he received his A.B. He later received a J.D. from New York University School of Law. Relying upon his first-hand familiarity with computer platforms and applications and with business and legal issues in advanced technology and intellectual property development and protection, he has assisted clients ranging from individuals to industry leaders in computer and telecommunications software and hardware development, manufacturing, and distribution; computer networking and database design for Intranets and the Internet; the visual, performing, and electronic arts; and business, professional, and consumer services. He currently engages in a business and technology consulting and legal counseling practice in California's Santa Clara ("Silicon") Valley.